Lyons M, Smith C, Boaden E, Brady MC, Brocklehurst P, Dickinson H, Hamdy S, Higham S, Langhorne P, Lightbody C, McCracken G, Medina-Lara A, Sproson L, Walls A, Watkins C.

Oral care after stroke: Where are we now?.

***European Stroke Journal* 2018,**

https://doi.org/10.1177/2396987318775206

Oral care after stroke: where are we now?

Abstract

The provision of high quality oral hygiene ~~is a~~should be a priority for patients ~~who have had a~~ following stroke. Despite numerous advances in technology, treatments and care pathways, there is a lack of robust evidence about how best to provide good basic oral care for people in the acute and rehabilitation stages following a stroke. In this paper, we aim to review what is known about current practice and guidelines, and examine the latest research evidence to support the provision of oral health care for people sufferg stroke~~in peoplestroke victims who have had a stroke.~~ We ~~will~~ then present a consensus statement on ~~identify~~ gaps in our knowledge and what further research is needed.

Periodontal disease and stroke have many risk factors in common and poor oral health is prevalent in people who have had a stroke. There is increasing evidence to suggest an association between poor oral hygiene and increased risk of aspiration pneumonia – a leading cause of mortality post stroke. However, there is a lack of strong evidence to determine whether good oral hygiene reduces risk of pneumonia or mortality.

The provision of good oral care for people who have had a stroke can be challenging, but is considered important by stroke survivors and their carers. Current provision of oral care tends to be of poor quality and is often delegated to the least qualified members of the caring team. Nursing staff lack support and are often working in a pressured environment where other aspects of clinical care have priority. Guidelines that exist are based on weak evidence and lacking in detail so are not very helpful.

There is also a lack of knowledge about how best to provide oral care at the different stages in the patient journey; from when stroke patients are critically ill or suffering from dysphagia to the rehabilitation stage or when oral care is provided in a nursing or care home.

Clinically relevant, effective, feasible evidence based oral health care interventions to improve patient outcomes in stroke care are urgently needed.

Introduction

A stroke is disabling and impacts on ADL

For those who survive, life after a stroke often changes dramatically as they and their families learn to live with the disabling consequences such as paralysis, muscle weakness, cognitive impairment, fatigue, anxiety and depression.[1, 2] Normal daily activities that contribute to the maintenance of oral hygiene such as eating, drinking and tooth brushing can be severely disrupted.[3]

Why oral health matters

~~This matters because g~~Good oral hygiene contributes to quality of life and inadequate maintenance can lead to serious short and longer-term health consequences.[4, 5] The impact of poor oral health on physical, psychological and social wellbeing is often underestimated and oral care is important for all stroke patients.[6-11] Aspiration pneumonia causes the highest attributable mortality of all medical complications following stroke.[12-14] Evidence of the impact of poor oral hygiene on health outcomes for medically or physically compromised patients continues to build and improving oral hygiene and plaque control appears to reduce the risk of significant life threatening complications such as pneumonia.[15-19]

Commented [SH1]: Once this is ready for publication, do you think we should alter the title: For example: "Evaluating oral care after stroke: a review of the literature and consensus statement"

Commented [SC2]: This could be merged into the above text to complete the abstract

Commented [SH3]: This section does not sit well in the abstract section – it seems to duplicate some of the abstract's first paragraph and almost feels more like Key Learning Points. Should we bullet point this section and call it that instead?

CJS: I agree - depending on the journal, some "key learning points" would be good

Commented [SC4]: Although there is limited evidence to date in patients with stroke

Why oral hygiene is more difficult after a stroke and problems that develop

The disabilities experienced, coupled with the disruption associated with being hospitalised can make it more difficult for stroke patients to attend to their own oral hygiene effectively.[20] Following a stroke, many patients feel embarrassed, worried and anxious.[8] Poor oral care can contribute to oral discomfort and pain, and lead to halitosis, ulcers, xerostomia (dry mouth), abrasions, oral infections (especially oral candidiasis), denture wearing and more latterly periodontal disease and tooth decay.[21-30] Oral problems can affect overall recovery, by impeding adequate intake of food and liquids, leading to an increased risk of dehydration, poor nutrition ~~and~~ as well as impacting on social interactions with exacerbation of communication difficulties.[8, 11, 31 32]

What is to follow

In this paper, we aim to review the latest research on oral health in people who have had a stroke and the care dilemmas this creates whilst in hospital and after discharge into the community~~wards~~. We reflect on what people who have had a stroke and their carers think about the oral care patients receive and investigate the challenges of its provision in this population. We aim to identify gaps in knowledge about optimum oral care for people who have had a stroke and areas where further research is needed to provide the evidence to support good practice.

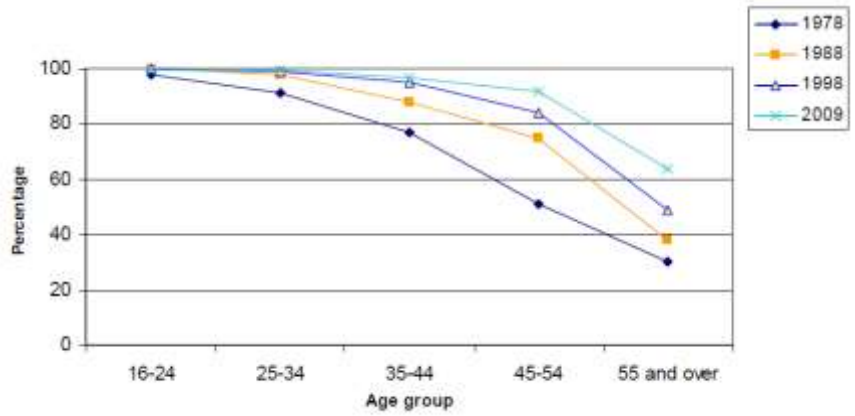
Epidemiology

Oral status of older population / average stroke patient

The world's population is ageing and nearly every country in the world is experiencing growth in the number and proportion of older people in their populations.[33, 34] In many low and middle-income countries the incidence of stroke is increasing but even in many western countries where it is decreasing, the actual number of strokes is rising because of the ageing population.[35] Globally, the average age at which people have a stroke is 71 years, and whilst stroke can affect people of all ages, many stroke patients are elderly.[36] With improving oral care over recent decades, the proportion of elderly people who remain partially dentate i.e. have at least one natural tooth, is increasing.[37-39] The majority of adults in the UK (even those over 85 years) are now dentate and of the adults aged 85 years or older, 26% have 21 or more natural teeth and are able to eat and drink reasonably well without dentures.[40]

Figure 1~~Figure 1~~ shows the improving pattern of dentition between 1978 and 2009 in England.

Figure 1 Trends in percentage of adults with 21 or more natural teeth by age, England 1978-2009



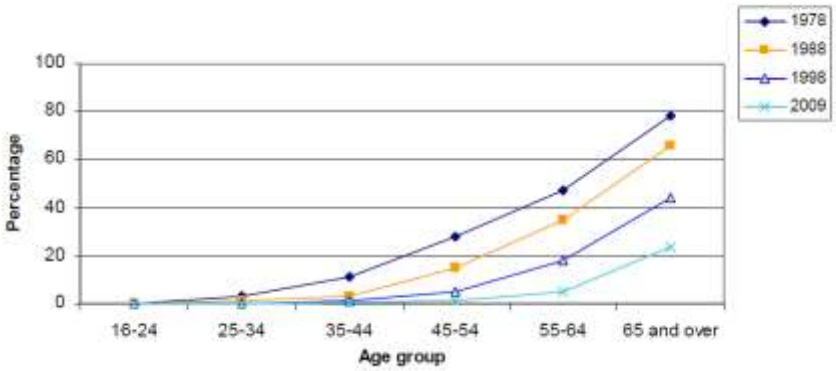
With older age, the ability for self-care tends to deteriorate, risk of xerostomia associated with poly-pharmacy increases and diets tend to become richer in sugars; all of which heighten the risk of oral disease and the need for oral care.[9, 41-43] The costs of treatment of oral disease in the member states of the European Union is expected to rise from €54 Billion in 2000 to €93 Billion in 2020.[44] A significant proportion of these costs in the future will relate to the provision of oral care for dependent older people.[45] Oral care service provision for older people can be challenging and is often inadequate.[46, 47] The quality of oral care provided especially for those living in nursing homes or who have had a stroke is poor and is often given low priority by nurses.[46-48] Income-related inequality in dental service utilisation and oral health inequalities amongst older people is also common.[49]

Despite improvements in dental services and dental health only one per cent or less of adults above the age of 55 are described as having excellent oral health.[39] Many elderly people were not exposed to fluoride at an early age and dental decay in this population is now a greater public health issue than it was twenty or more years ago.[50] Although considerably more people are surviving into old age with some natural teeth, most have a ~~considerable~~ sizeable number of restorations (fillings and implants), and periodontal disease disproportionately affects this section of the population and is associated with increased risk of oral problems such as implant failure.[51]

The edentulous elderly tend to have better oral hygiene than those with partial dentition,[52] and

Figure 2~~Figure 2~~ indicates how the risk of being edentulous, particularly in the older population, has between 1978 and 2009.

Figure 2 Trends in percentage edentate by age, England: 1978 - 2009



What do we know about the oral health of stroke survivors?

People who have a stroke tend to have worse oral health than a comparable group in the population. A scoping review of oral care post stroke included a case-control study from Japan, which found that stroke survivors aged 50 to 70 years have fewer natural teeth and are more likely to wear dentures than a control group of a similar age who had not had a stroke.[53, 54] A 2014 systematic review and meta-analysis of clinical, microbiological, and behavioural aspects of oral health among patients with stroke found that they had poorer clinical oral health status across a range of parameters (tooth loss, dental caries experience, and periodontal status) than healthy controls.[55] A narrative review and a systematic review identified a strong association between periodontal disease and stroke.[56, 57]

The link between oral health and cardiovascular disease, stroke and diabetes is becoming more clearly established but the relative importance of risk factors such as smoking, poor nutrition and diabetes, being more common in both ~~that~~ stroke and individuals with poor oral health ~~have in common~~ is unclear.[56] Although a cause and effect relationship cannot be presumed, there is a growing body of work suggesting that the inflammatory processes associated with periodontal disease may be linked to the ~~increase~~ risk of stroke.[58-62]

Interventions to improve oral hygiene may therefore have an impact at a systemic level and reduce risk of stroke as well as increase comfort.[63-66]

Why oral hygiene can be problematic after a stroke/mechanisms

The link between the presence of dental plaque (~~,~~ which is an oral biofilm), to the most prevalent diseases affecting the oral hard and soft tissues (~~,~~ caries and periodontal diseases) is long established.[25, 67, 68] The initiation, progression and stability of these diseases is profoundly influenced by effective oral care behaviours that control dental plaque, especially daily tooth-brushing aided by other oral care products (toothpastes, mouthwashes, interdental cleaning aids). The accumulation of dental plaque and the increased oral bioburden associated with poor oral hygiene acts as a potential reservoir for respiratory pathogens and may increase the risk of important life-threatening

Commented [SC5]: Data from epidemiological studies linking periodontal disease to stroke/cardiovascular disease has been criticised for likely residual confounding etc

Commented [SC6]: This section mixes a) how poor OH may worsen outcomes after stroke; and b) how stroke may impact adversely on OH.

sequelae such the development of aspiration pneumonia.[9, 29, 41-43, 54, 55, 61, 69-72] There appears to be a higher than normal pathogenic bacterial and yeast count in the oral cavity in the acute phase of stroke, which may increase the risk of pneumonia following aspiration ~~ie~~into the lungs.[73-75]

Although the exact mechanisms that account for the association between poor oral hygiene and stroke remain unclear, it is likely that a number of factors disrupt ~~the~~ oral ecology and increase the propensity for oral hygiene problems following a brain injury such as stroke. Extrinsic or environmental factors include hospitalisation, reduced food and drink intake, increased exposure to antibiotics and dependency on nursing care. Xerostomia can be a particular problem in stroke patients because of oxygen therapy, mouth breathing, side-effects of medication and reduced food and fluid intake, and can lead to low salivary production and dehydration.[76, 77] Nasal oxygen therapy, mouth breathing, intermittent suction as well as restricted oral intake can all make dehydration worse.[24, 78]

Intrinsic factors relate to the reduced oro-lingual control and increased somnolence experienced by many stroke patients. Oro-motor paresis may lead to poorly fitting dentures and denture stomatitis,[30] which can affect masticatory function. Reduced tongue pressure[79] and altered lateral movements during chewing increase the number of chews needed and time taken to chew food[80] and can result in food pooling in the sulci of the mouth.[81] Loss of sensation (touch and taste) in the mouth can also affect the swallow reflex[82] and contribute to an increased risk of aspiration. Dysphagia can affect as many as half of all patients who have recently had a stroke[83] and is an independent risk factor for increased mortality, increased length of stay in hospital and adverse longer term outcomes.[84] Much of the latter seems to relate to the associated seven-fold increased risk of aspiration pneumonia.[85] An ineffective swallow causes a change in the handling of both saliva and food debris within the oral cavity, nasopharynx and oropharynx, and it is likely that some degree of stasis and stagnation takes place. In association with changes in salivary function, which are often more common in elderly patients, this increases the risk of oral colonisation and affects ~~any~~ the physiological clearing mechanisms that already exist to ensure that the mouth remains healthy.

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Oral assessment

A prompt oral examination and assessment in patients who have had a stroke will identify problems that if left untreated could affect recovery. Without ~~a~~ implementation of good oral assessment and dental care protocols~~lan~~, good oral hygiene post stroke is frequently overshadowed by other more pressing health care needs. Few tools are available to assist with the assessment of oral health and development of treatment and care plans.[54] Those that are available are often not used, which may be due to a lack of time or knowledge by bedside nurses and carers.[86] An initial oral examination should include a quantitative or semi-quantitative plaque score,[87] as well as a general assessment of the condition of the lips, intra oral soft tissues and hard tissues. Nurses are best placed to carry out the initial general oral assessment and can be trained to identify patients who need referral to a dental specialist for confirmation of disease and treatment.[88]

Commented [ML8]: Mary Harrison's work?

Those~~e~~ oral assessment protocols that are available for use by nurses are generally based on models that score oral health features such as saliva, soft tissues and odour,[89] with modifications including dental plaque levels,[90] oral function, swallowing, voice quality, and hard tissues assessment suggested in some.[91] There are specific oral assessments designed for patients with tracheal tubes present[92] or who are orally intubated.[93] The 'BRUSHED' assessment (Bleeding, Redness, Ulceration, Saliva, Halitosis, External factors, Debris) is a useful mnemonic designed to prompt nurses to assess these important oral health signs and symptoms.[94] The holistic and reliable oral assessment tool

(THROAT) was originally developed to assess oral health in elderly hospitalised patients, but is helpful and feasible to use in dysphagic acute stroke patients.[95]

Management and care

Following a moderate or severe stroke, the level of perceived disability may be significant.[30] Patients are often highly dependent on staff for oral care to keep dentures or remaining teeth and oral tissues in good condition.[54] A large longitudinal study derived from the Swedish stroke register found that on average one year after a stroke, dependency for activities of daily living was 28.3%.[96] Oral care in the early days after a stroke can be complicated where swallow safety is compromised, as patients may be unable to keep any food residue, toothpaste or rinsing fluids from entering their airway. However, the provision of high quality oral hygiene should be a priority and is of paramount importance for the safety and comfort of patients who have had a stroke.[97-99] Unfortunately, there is currently no consensus guidance for best practice in assessment of need, equipment to use, procedure to follow or how frequently oral care should be provided. Practice in different locations varies widely and staff have reported feeling insufficiently trained to deliver oral care effectively.[97, 100]

Providing oral health care to patients with different care needs after stroke~~s~~ and dental profiles (those with natural teeth, dentures, both or neither) within various stroke care settings is challenging and very little is known of the landscape of usual care. Despite clearly motivated nursing staff, a survey of 71 Scottish stroke care sites (with a 99% response rate) found that stroke nurses and clinical support workers lack the support required to provide adequate oral health care.[101] Staff received specialist training in oral health care in just 13% of sites and only 21% had a protocol in place for oral health care. Stroke patients had access to an oral health care assessment in approximately one fifth (22%) of sites. Some sites had no toothbrushes (26%) or toothpaste (29%) available for patients. Oral health care standards varied considerably across sites with some aiming to clean patients' natural teeth (13%) or dentures (26%) just once a day while others aimed for cleaning after every meal.[101] Oral health care was often delegated to unregistered members of the multidisciplinary team such as clinical support workers or student nurses.[101, 102] Despite a degree of shared understanding of what good oral health care might include, there were clear inconsistencies in provision across sites. Defining the essential components of a complex intervention such as oral health care after a stroke is a challenge.[98] Well designed evidence-based intervention programmes do improve the quality of care for those who have had a stroke, with significant benefits to patient outcomes.[103] Though there is some indication that adequate oral health care may reduce the incidence of stroke associated pneumonia and improve patients' oral health, comfort and quality of life,[98] definitive evidence is still lacking.

The current lack of appropriate training and prioritisation of oral care within the stroke patient pathway serves to increase health inequalities as it has the biggest impact on patients with greatest need who are at high risk of complications.[104]

Patient, carer and professionals' perspectives

Commented [SC9]: This duplicates/overlaps with the "Evidence base" section

Also, Wagner et al, 2016 study re pneumonia (before and after intervention implementation study)

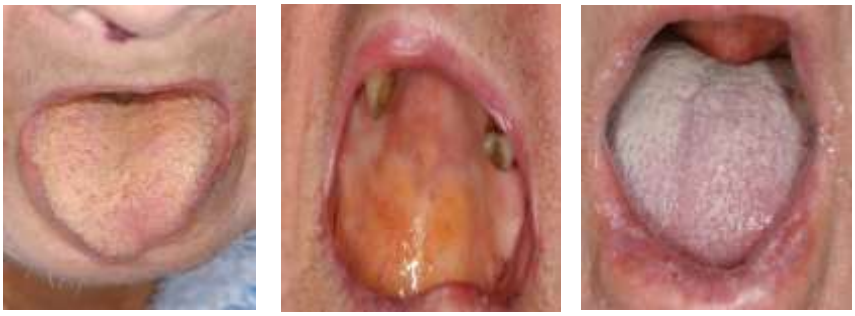
Commented [SC10]: Additional patient/carer/HCP themes available from Maria Horne's paper if needed

Table 1~~Table 1~~ highlights data from a study about improving the evidence base for oral assessment patients.[105] It provides insights into the provision of oral care after a stroke from a range of perspectives. It is interesting note the convergence of opinion about the importance of having a clean oral cavity, whilst acknowledging the challenges in providing oral care to stroke patients.

A person's experience and attitude to oral health is related to their own health beliefs.[106] Many patients report a lack of oral care, especially in the acute phase after a stroke, and that nurses make (~~often incorrect~~often-incorrect) assumptions about patients' ability to attend to their own oral cases this lack of oral care affects the patient's relationship with their family and friends.[105] Patients report reduced oral functioning, pain, discomfort, limited ability to remove food, chew and control saliva all of which impact on their sense of wellbeing.[8, 107] The lack of control over their saliva and reduced ability to clean their oral cavity properly, makes patients feel anxious and distressed about their appearance, fear they have halitosis and it affects their ability to communicate effectively with others.[105]

Relatives and friends expressed empathy about how their loved one must feel when they have an unclean oral cavity[97, 105] Relatives found it unpleasant and distressing because it affected their relationship, making them reluctant to give their loved ones a kiss or hug of support.[105] Figure 3 provides some images of the unpleasant and distressing state of the oral cavity in stroke patients.

Figure 3 Oral cavity in stroke patients



Commented [SH11]: Does this ned more description of what is being shown – coating tongue, tooth decay, sore throat etc.

Commented [LS12]: I agree, could we also have a picture showing hardened mucus plaque on the soft palate – I encountered this frequently on wards and it often scared mouth care providers, re causing pain if removed/parts of the plaque falling into the airway. Unfortunately this often resulted in missed chances to provide mouth care. This links to our points re need for training for staff.

Oral care is regarded as a basic need and some relatives found it difficult to comprehend why it had not been provided for their loved ones, but at the same time felt powerless to intervene and provide the care themselves.[105] Many factors contribute to poor oral care. These include fear of possibly causing harm, feelings of powerlessness among patients and relatives, lack of skill or ability,[6] lack of time,[108] low priority,[108] nurses' inadequate knowledge,[108, 109] inadequate resources,[110, 111] inadequate education of patient and carers[105] and a lack of guidance and evidence to support oral care provision.[110, 111]

Table 1: Key points from patient carer and professionals' perspectives[105]

Finding	Participant	Example quotes
Oral care is perceived as important by patients' carers and professionals. It has an impact on overall wellbeing and quality of life as well as preventing systemic and oral disease and discomfort. But there is an acknowledgement that for elderly patients who have had a stroke, oral care may not be the top priority.	Patient	*Well I think it's very important for the simple reason if you don't look after your mouth, the germs are going right through your body. (Patient R)*
	Carer	*For us, it's important, but I think when you start getting to his age, I think he's got too many other issues that are more important than his mouth. (Carers E and J)*
	Health care professional	*Oral care is really important, impacts on quality of life, nutrition, systemic issues, comfort, pain and social interaction. (Stroke researcher and speech and language therapist E)* *I think it's important particularly for our patients with swallowing problems because they might not be able to apply the oral hygiene … In terms of saliva management some of our patients have difficulties managing their saliva … they are more at risk of aspirating it … it's whether that saliva's clean or not … potentially they're aspirating saliva that could contain bacteria." (Focus group two with health professionals)* *I do accept that some people just don't bother … very low on their priorities. I think it depends on … your self-esteem, your self-awareness (Dental hygienist P)*
Lack of care is common and has a big impact on the patient and their families. It makes the patient feel uncomfortable, and adds to the powerlessness they feel. Patients find it difficult to ask for what they need. Family and friends are aware of the unpleasantness of the situation, but also feel powerless and lack the knowledge and skills to provide oral care.	Patient	*I don't think anybody actually cleans people unless they are absolutely immobile. I don't think anybody, … nobody's cleaned my teeth (Patient M)* *Well you know when you are so dry I just didn't like it. It was uncomfortable … it has been horrible. (Patient E)* *I don't know whether it's because I don't want to bother them, … ask them, say can I clean my teeth again … I don't know. (Patient A)* *I mean you don't want bad breath do you ….to make them look good and feel good. (Patient E)* *I could never understand why they never asked you to clean your teeth … Unless it was, I was so, I was so poorly then I couldn't do much at all then at the time. (Patient A)*
	Carer	*You could see like a real like yellowing filmy stuff over his teeth, then sort of white patchy scaly bits on his tongue. And sometimes it was very very dry, so it was like a - you know*

		snake-skin handbag type of thing. It was really cracked and hard. His tongue yeah and - you know, round his gums and that sort of thing and you know you're wanting to go and give him a kiss to reassure him and give him a love but … at the same time kind of thinking hmm no, no. And it's awful because it's your dad and you shouldn't have to feel like that." (Carer J) *Mouth care is making sure the mouth's clean - you know as best could be. It's like your own oral hygiene, you know you look after that, so why can't it be looked after in a sick patient. I feel disgusted at the way - I'm not disgusted that's a wrong word - surprised, very surprised. I never thought somebody's mouth could go like that through lack of care. (Carer D).* *In the latter stages they've dealt with it very well. In the initial stages in the acute stages … I think it could have been improved … Improved quite easily really with not a great deal of resources. Would have made life a lot better for him." (Carer J)*
There are significant barriers to providing good oral care following a stroke. There is also uncertainty and fear about the best way to provide oral care for stroke patients. There is a lack of knowledge, and resources to provide adequate oral care	Health care professional	*We do use toothbrushes sometimes but tend not to use toothpaste as they tend to aspirate on the toothpaste. So we use the mouth wash. Which we just rinse the tooth brush in rather than have all the bubbles. (Focus group one with health professionals)* *Barriers are patients clamp and stop nurses from going into the mouth. Patients fighting us." (Focus group one with health professionals)* *Not all patients have the correct equipment and often toilet bags have everything in them other than toothbrush and toothpaste. Often equipment not available on the ward for the staff to use." (Focus group one with health professionals)* *If you've got a stroke victim it can sometimes be quite difficult, and sometimes patients can fight you which basically means you're less keen to sort of you know to try, but I always found that with stroke victims, spitting is always quite difficult or mouth rinsing is quite difficult as well. There's the fact that actually it's quite difficult to brush somebody's teeth if they're laid on a on a bed sort of a supine position. It's very difficult to get at the right angle. (Public health dentist W)*

		I think a lot of these jobs are left to the care assistants now, because the qualified nurse's job is very much more acute, and clinical - you know as in doing blood pressure, giving drugs cos of the way things are at the minute. (Stroke specialist nurse C) *Also lack of support for nurses … limited access to formal training, often don't have access to appropriate equipment. (Stroke researcher and speech and language therapist E)*

Evidence base

There are many challenges and a lack of evidence about how best to provide oral care for people who have had a stroke. Even when assistance with oral care is offered, resistant behaviour can be a major barrier.[10, 50, 112, 113]

A Cochrane systematic review on interventions for improving oral hygiene following a stroke was originally undertaken in 2006 and updated in 2011.[5] Since then several studies have been undertaken. Table 2~~Table 1~~ provides an overview of this and the relevant new research on oral care stroke patients. Only seven of the studies are stroke specific, others include combined data from stroke and other patients in a range of settings.

Two older non-stroke specific nursing home based studies, one from Japan (2002) and the second from the USA (2008) evaluated the impact of an oral health care intervention in a setting where there were a number of stroke patients.[17, 114] Both studies reported fewer cases of pneumonia (or related death) amongst residents that received oral health care. Few intervention details were reported but the Japanese trial excluded incapacitated, dysphagic, unstable and unconscious residents unable to give consent; individuals often in most need of supported oral health care.[17] Unfortunately, in many trials the patients who are most dependent on support for oral care i.e. those with impaired cognition, consciousness or communication are often excluded.

The overview in Table 1 shows there is a paucity of strong evidence in the literature on how best to prevent oral disease and improve care for stroke survivors.[54]

Table 2~~1~~: Review of evidence base

No	Study	Year	Overview
1	Brady MC, Furlanetto D, Hunter R, Lewis SC, Milne V. Staff-led interventions for improving oral hygiene in patients following stroke.[5]	2006 (updated 2011)	A Cochrane systematic review (undertaken originally in 2006 and updated in 2011) on staff-led interventions for improving oral hygiene following a stroke included three small randomised controlled trials (RCTs).[5] Only one trial (Gosney 2006) was based in a specialist stroke care setting.[115] In this trial involving patients in a stroke ward (n=203), highly intensive application (4 times daily) of a decontamination gel was compared to placebo over a three week period.[115] Fewer patients who received the decontamination gel developed pneumonia (p=0.029) but mortality was unchanged. In the second

Commented [SC13]: Resistance from both patients and staff!! E.g. staff concerns about causing harm/ perceived lack of lack of time/training etc

Commented [SH14]: Do you need to say what method of lit review was undertaken here – PRISMA or something else? Which databases were screening – what key words were used what time frame was searched?

CJS: Agree with Shaheen; search needs to be tightened up

Commented [SC15]: Wondered if:
a) systematic review evidence should be considered separately from other evidence (e.g. Marian's SR only considered RCTs I think; so would not capture non-RCTs)
b)Splitting the table into more structured headings e.g. Study/year, design, environment, participants, objective/intervention, main finds etc

Commented [LS16]: Can we suggest that the literature overview also evidences the urgent need to improve mouth care?
Agree that splitting the table under section headings would be helpful

Commented [SC17]: Evidence base for interventions/oral hygiene approaches?

Commented [SC18]: Whilst a supporter of oral decontamination to prevent pneumonia (i.e. MAPS-2), this to my mind is not really oral hygiene as such? Dentists and other disciplines may disagree!!

			trial (Frenkel 2001), stroke specific data (n=67) from one small cluster RCT in a UK nursing home setting reported that an oral health care staff training intervention improved staff knowledge and attitudes which in turn benefited residents' denture (but not dental) cleanliness.[116] The third RCT (Fields 2008)[117] was terminated early as precise baseline, randomisation and outcome data were inadequately reported and so definitive effectiveness could not be determined. The findings were therefore not included in the meta-analysis, but an overview of the trial is given below. Overall, the Cochrane review concluded that the provision of training in oral health care interventions can improve staff knowledge and attitudes, the cleanliness of patients' dentures and reduce the incidence of pneumonia. However, evidence was weak and improvements in the cleanliness of patients' teeth were not observed.
2	Fields LB. Oral care intervention to reduce incidence of ventilator-associated pneumonia in the neurologic intensive care unit.[117]	2008	This was a randomized controlled trial with ventilated stroke and other high-risk medical patients on a 24-bed intensive care unit in the USA. The intervention group (n=200) were provided with usual care, plus staff training for implementation of a tooth brushing protocol every eight hours, plus kit The control group received usual care, which could include daily tooth brushing along with other mouth care as needed. The ventilator associated pneumonia rate dropped to zero within a week of beginning the tooth-brushing regime in the intervention group. The study was so successful that the control group was dropped after six months, and all intubated patients' teeth were brushed every eight hours, maintaining the zero rate of ventilator-associated pneumonia until the end of the two year study.
3	Lam OL, McMillan AS, Samaranayake LP, Li LS, McGrath C. Randomized Clinical Trial of Oral Health Promotion Interventions Among Patients Following Stroke.[59]	2013	The setting for this three arm RCT was a stroke rehabilitation ward in Hong Kong. All groups were provided with an electric toothbrush and standard fluoride toothpaste. There were 102 patients randomly allocated. Group one received oral hygiene instruction only, group two received this plus chlorhexidine mouthwash and group three received the same as two, plus some assistance with brushing twice a week. The trial continued for three weeks. Neglect and poor oral hygiene was noted in all groups

			at baseline. Significant reductions in dental plaque and gingival bleeding were noted in both intervention groups 2 and 3 compared to group1. There were no cases of pneumonia recorded at all during the trial, so the impact on pneumonia could not be ascertained.
4	Lam OL, McGrath C, Li LS, Samaranayake LP. Effectiveness of oral hygiene interventions against oral and oropharyngeal reservoirs of aerobic and facultatively anaerobic gram-negative bacilli.[118]	2012	This was a literature review of studies that evaluated the effectiveness of oral hygiene interventions in reducing the oral and oropharyngeal carriage of aerobic and facultatively anaerobic gram-negative bacilli in medically compromised patients. It was not specific to stroke patients. Aerobic and facultatively anaerobic gram-negative bacilli (AGNB) are opportunistic pathogens that cause a large number of hospital-acquired infections and have been linked to nosocomial pneumonia and septicaemia. Although AGNB are not considered members of the normal oral flora, medically compromised patients appear to be susceptible to AGNB colonisation. The review concluded that the effects of antiseptic agents could not be discerned from the adjunctive mechanical oral hygiene measures employed concurrently. Whereas some success against oral and oropharyngeal AGNB carriage has been reported with higher chlorhexidine concentrations (2%), their use may be limited by accompanying adverse effects. The effectiveness of 0.2% chlorhexidine formulations remains equivocal, with studies reporting reductions, absence of effect as well as increases in AGNB carriage. The authors conclude that there is a pressing need for additional high-quality RCTs to determine which oral hygiene interventions or combination of interventions are most effective in eliminating or reducing AGNB carriage. This determination will affect practice in hospitals and could potentially reduce the rates of respiratory and other nosocomial infections among large and varied patient populations.
5	Chipps E, Gatens C, Genter L, Musto M, Dubis-Bohn A, Gliemmo M, et al. Pilot Study of an Oral Care Protocol on Post-Stroke Survivors.[119]	2014	This was a ten day randomised controlled pilot study undertaken specifically with 51 post stroke patients in an acute rehabilitation hospital in the USA. A standardised oral care intervention involving tooth brushing, tongue brushing, flossing, a mouth rinse and lip care performed twice a day was compared to usual care. All patients in the intervention arm were provided with a battery powered toothbrush and other oral care supplies. Primary outcomes were the

			condition of the oral cavity assessed using a revised THROAT score, intake of food and liquids, severity of dysphagia and mucosal colonisation with methicillin sensitive and methicillin resistant *Staphylococcus aureus*. Subjects in both groups showed improvement in their oral health assessments, swallowing abilities and oral intake over time, but the two groups were not statistically significantly different from each other. Overall prevalence of methicillin-resistant and methicillin-sensitive *Staphylococcus aureus* colonisation in the control group almost doubled (from 4.8% to 9.5%), while colonisation in the intervention group decreased (from 20.8% to 16.7%) but again differences were not statistically significant. The authors felt that the results were of value, but the study had several limitations. Sample size was relatively small, staff and patient satisfaction was not formally assessed, only colonisation with *Staphylococcus aureus*. The oral microbiome is complex and it was impossible to assess the relative importance of the various aspects of the intervention. The authors recommend further studies to explore the impact and acceptability of different oral care protocols.
6	Kuo YW, Yen M, Fetzer S, Lee JD, Chiang LC. Effect of family caregiver oral care training on stroke survivor oral and respiratory health in Taiwan: a randomised controlled trial.[120]	2015	The aim of this two month long single-blind, randomised, controlled trial was to evaluate the effectiveness of a home-based oral care training programs on tongue coating, dental plaque and symptoms of respiratory infection in stroke survivors in Taiwan. Over a period of two months, stroke survivors (n=48, intervention group) and their family caregivers received a home-based oral care training programme, with regular reinforcement of tooth brushing technique, while a control group of 46 stroke survivors and family caregivers received routine oral care education. A trained nurse and a research assistant with nursing experience delivered the intervention. Poor oral hygiene and neglect of oral care was observed at baseline. The group who received the training programme had significantly lower tongue coating and dental plaque scores than the control group after two months. There was no difference in symptoms of respiratory infection between the groups.
7	Dai R, Lam OL, Lo EC, Li	2015	This was a systematic review of observational studies

	LS, Wen Y, McGrath C. A systematic review and meta-analysis of clinical, microbiological, and behavioural aspects of oral health among patients with stroke.[55]		relating to oral health outcomes and oral health related behaviours in patients with a stroke. The authors found that patients with stroke experienced poorer oral health than healthy controls and prior to the stroke tended to be less frequent dental care attenders. They recommend further studies based on standardised assessment criteria of clinical oral health status, and with behavioural and microbiological outcomes to confirm findings. Due to the chronic nature of periodontal disease and other oral health measures such as number of decayed, missing or filled teeth, the authors suggest that dental health among stoke patients could be worse than healthy controls prior to the stroke, although this could not be confirmed given the dramatic deterioration in oral hygiene that often occurs soon after a stroke.
8	Horne M, McCracken G, Walls A, Tyrrell PJ, Smith CJ. Organisation, practice and experiences of mouth hygiene in stroke unit care: a mixed-methods study.[97]	2015	This study investigated provision of oral care in stroke units in greater Manchester. The authors explored stroke survivors' carers' and healthcare professionals' experiences and perceptions about the barriers to providing oral care in stoke units. They found a lack of understanding of the importance of oral care. There was inconsistent practice, a lack of equipment and materials, and inadequate training and education for staff and carers. The paper highlights the need for improved training and provision of oral care for patients with stroke. The authors suggest that oral care post-stroke could be improved by increasing patients', carers' and healthcare professionals' awareness, knowledge and understanding of the wide ranging benefits of oral care following a stroke.
9	Juthani-Mehta M, Van Ness PH, McGloin J, Argraves S, Chen S, Charpentier P, et al. A cluster-randomized controlled trial of a multicomponent intervention protocol for pneumonia prevention among nursing home elders.[121].	2015	This was a non-stroke specific cluster randomised controlled trial conducted in 36 nursing homes in the USA. The study was undertaken with residents who had impaired oral hygiene or swallowing difficulties and were considered at high risk of pneumonia. Approximately 23% of participants had experienced a stroke. The intervention consisted of manual tooth/gum brushing plus 0.12% chlorhexidine oral rinse delivered twice a day and upright feeding position compared to usual care. Participants were followed for up to 30 months. Although there were fewer cases of pneumonia in the intervention group, the difference was not statistically significant and the study was terminated for futility. The authors

Commented [SC19]: This study perhaps sits less well in this table, as a mixed methods evaluation of oral care provision. Our follow-on study (Smith et al, 2016) using the chlorhexidine-based brushing regimen might be a better alternative?

Commented [SC20]: Not sure what others think, but I'd be inclined not to stray into care home territory here, it's a very different environment which poses different challenges and objectives of intervention, and there are actually quite a few OH studies out there in that setting.

			suggested that other innovative strategies require investigation to reduce risk of pneumonia in this vulnerable group.
10	Kim E-K, Jang S-H, Choi Y-H, Lee K-S, Kim Y-J, Kim S-H, et al. Effect of an oral hygienic care program for stroke patients in the intensive care unit.[122]	2014	This randomised controlled trial explored the impact of an oral hygiene care programme delivered to patients who had recently experienced their first stroke and were being cared for in the intensive care unit (ICU) of a university hospital in Korea. The randomisation process employed was not clear and included the selection of matched controls, which could create a risk of bias. The intervention consisted of tooth brushing using a child's toothbrush, and an interdental toothbrush, cleaning the tongue followed by cleaning the mucosa with gauze soaked in 0.5% chlorhexidine. It is not clear what the intervention was compared to, but the implication was that this was usual care. A dentist delivered the outcome once a day. Outcomes were assessed after a variable period of on average 2.2 weeks depending on how long the patient remained in the ICU. A dentist and an oral hygienist assessed outcomes. The group did not explore the impact of the intervention on systemic infection. The trial found that the plaque index, the gingival index and the presence of candida in the saliva were significantly lower in the intervention compared to the control group. There was no significant difference between the groups in clinical attachment loss or presence of candida albicans on the tongue.
11	Seguin P, Laviolle B, Dahyot-Fizelier C, Dumont R, Veber B, Gergaud S, et al. Effect of oropharyngeal povidone-iodine preventive oral care on ventilator-associated pneumonia in severely brain-injured or cerebral hemorrhage patients: a multicenter, randomized controlled trial.[123]	2014	This was a non-stroke specific multi-centre, double blind randomised placebo controlled trial conducted in six intensive care units in France. The intervention consisted of washing the oropharyngeal cavity with diluted povidone-iodine or placebo. There was no difference between the intervention and placebo groups in primary outcome, which was the rate of ventilator-associated pneumonia. There were no differences between the groups in relation to the secondary outcomes, such as delay in infection, length of stay and mortality. An unexpected finding was that acute respiratory distress syndrome occurred in five patients in the povidone-iodine group but not in patients in the placebo group (p = 0.06). The authors conclude that there was no evidence to recommend oral care with povidone-iodine to prevent ventilator-

Commented [SC21]: Would also include Wagner et al, 2016, as described earlier

			associated pneumonia in high-risk patients. The authors note that the use of povidone-iodine in this group of patients seemed to increase the rate of acute respiratory distress syndrome.

There are several sets of guidelines that refer to oral health care following a stroke. A review of these is provided in Table 3~~Table 2~~. None give~~s~~ detailed guidance about evidence based oral care for who have had a stroke. Several refer to the lack of evidence to support detailed guidance. The National Institute for Health and Care Excellence (NICE) quality standards does not refer to oral care. Most of the guidelines provide very brief information. Answers to the basic questions about whether it is best to use an electric or manual toothbrush, size and type of head, which – if any toothpaste, how frequently care should be given etc. are not provided. Information to alleviate nursing staff anxieties such as the best way to reduce the risk of choking when providing oral care for dysphagic people who have had a stroke is not mentioned.

Table 3~~2~~ Guidelines that refer to oral health care in people who have had a stroke

Commented [SC22]: Comprehensive, yet very bulky table. Could we introduce some more subheadings e.g. making clearer whether stroke-specific or not etc? Would suggest trying to edit down somewhat, especially this first guideline! Also, look at chronological date ordering

No	Guideline	Year	Overview
1	Guidelines for the Oral Healthcare of Stroke Survivors: British Society of Gerodontology[6]	2010	These guidelines are the most comprehensive and provide an overview of the problems associated with stroke. However, they tend to focus on dental healthcare rather than basic nursing assessment and care. Section 3.2 says that oral health should form part of the early stroke unit assessment. In section 3.5 the guidelines say that the use of an oral health risk assessment follows recommendations of the Department of Health 'Essence of Care' (2003) and the Welsh Assembly Group 'Fundamentals of Care' (2003). An example of a suitable assessment is provided as an appendix, but this assesses dental risk rather than the condition of the oral cavity. The chapter says that a more comprehensive assessment that identifies equipment and nursing assistance needed may be used, but does not give any examples. It says that continual monitoring of oral health is needed until independence is resumed. Section 4.2 mentions that there is little published evidence regarding the oral health of people who have experienced a stroke, but stress the need to maintain a high standard of oral hygiene. The guidelines suggest that an oral hygiene care plan should be developed based on specific protocols and these are described in an appendix. A key point is that brushing the teeth of a stroke survivor with dysphagia should be done using aspiration and a small amount of toothpaste. The protocols referred to are basic, not very detailed and are taken from the British Society for Disability and Oral

			Health (BSDH) Guidelines.[124] Section 4.6 is all about xerostomia. The authors mention that dehydration is an underreported problem that may contribute to a dry mouth. They describe the latest evidence about the best ways to treat this common problem. Section 4.7 refers to the need to develop nursing care standards and guidelines to overcome the barriers to good oral health care experienced by stroke survivors.
2	Guidelines for the oral care of patients who are dependent, dysphagic or critically ill.[125]	2002	These UK guidelines are not specific to stroke patients, but are included here as many stroke patients experience dysphagia and critical illness. The guidelines are brief, and based on consensus from an expert working group[124] The guidelines recommend an oral assessment is carried out by nurses on admission. They recommend early identification and onwards referral for any problems amenable to medical, dental or nursing intervention. There is a good algorithm but minimal detail provided. A summary of oral care for dependent patients is presented as an appendix, but again lacks detail.
3	National clinical guideline for stroke; Fourth edition[126]	2012	These guidelines were prepared by the intercollegiate stroke working part of the Royal College of Physicians. Section 6.22 refers to oral health and includes a series of recommendations that are not highly detailed. They refer to brushing the teeth, ensuring patients with dentures have them cleaned and put in during the day. There is also a brief paragraph on the need for staff training.
4	Stroke rehabilitation in adults. Clinical guideline CG162	2013	This guideline developed by the National Institute for Health and Care Excellence (NICE) in the UK covers stroke rehabilitation for adults and young people aged 16 and over who have had a stroke with continuing impairment, activity limitation or participation restriction. Section 1,7,3 says staff should 'ensure that effective mouth care is given to people with difficulty swallowing after stroke, in order to decrease the risk of aspiration pneumonia.' No details are provided about how this should be done.
5	Stroke and transient ischaemic attack in over 16s: diagnosis and initial management. Clinical guideline CG 68	2008	This guidance developed by NICE does not mention oral care at all.

6	Promoting older people's oral health. RCN	2011	These guidelines were prepared by the Royal College of Nursing, supported by the Department of Health in the UK. Although stroke is mentioned as a long term condition that can impact on oral health, these guidelines do not include specific guidance for stroke patients.
7	Canadian Stroke Best Practice Recommendations: Acute Inpatient Stroke Care Guidelines,[127]	2015	Section 2.7 of these Canadian guidelines is all about oral care. The guidance suggests that all patients need an individualised assessment and care protocol. Stroke patients should be referred on for specialist dentist, occupational therapist, speech-language pathologist and/or a dental hygienist if needed. Much of the evidence cited to support the guidance is considered level C indicating that this comes from writing group consensus and / or supported by limited research evidence.
8	Clinical Guidelines for Stroke Management 2010[128]	2010	Section 7.2 of these Australian stroke guidelines refers to poor oral hygiene and says that all patients should have assistance and /or education to maintain good oral and dental (including dentures) hygiene, and that staff or carers can be trained in assessment and management of oral hygiene. The authors say that oral care can present a considerable challenge and that there is little evidence for strategies to maintain or improve oral hygiene after a stroke.
9	VA/DoD clinicial practice guideline for the management of stroke rehabilitation[129]	2010	These American guidelines make very little reference to oral care, and only say that 'An oral care protocol should be implemented for patients with dysphagia and dentures to promote oral health and patient comfort'.
10	Mouth care after stroke[130]	2009	These guidelines were based on a review by a group of physicians in the UK. The key points from these guidelines are that; ▪ Poor oral health and mouth care is strongly associated with diagnosis of stroke, progression of carotid artery stenosis, stroke related functional disability, and risk of aspiration pneumonia. ▪ Oral care is yet not perceived as a care priority and there are few training or care policies in place ▪ Further research is needed to evaluate the effectiveness of oral health-care interventions. The authors suggest that evidence supporting staff-led oral care practices is scarce.
11	Management of	2010	The Scottish Intercollegiate Guidelines Network (SIGN)

	patients with stroke: identification and management of dysphagia, a national clinical guideline No 119[131]		has produced three guidelines around stroke. The first is about assessment, investigation, immediate management and secondary prevention[132], the second is about rehabilitation, prevention and management of complications, and discharge planning.[133] Oral care is not mentioned in either of these. However, section 7.2.1 in this third guideline about the management of dysphagia and says that 'Good oral hygiene needs to be maintained in all patients to ensure that dental plaque is removed and pathogenic organisms are not allowed to proliferate in the mouth, preventing oral and dental disease and reducing the risk of aspiration pneumonia. This is particularly for patients with PEG or nasogastric tubes.' The group suggests that an appropriate oral care protocol should be used for every patient with dysphagia, including those who use dentures. These guidelines refer to the same algorithm as mentioned in the 'Guidelines for the oral care of patients who are dependent, dysphagic or critically ill'[125] already discussed.
12	National Service Framework for Older People in Wales[134]	2006	The importance of good oral health for its contribution to general health and wellbeing is mentioned throughout this document. There is a specific section on stroke, which reinforces this, but no further details are provided.

Oral care treatments

From a purely dental perspective, provision of basic oral care is important, since progression of dental caries over time is likely to lead to dental pain followed by abscess formation. Progressive periodontal disease leads to continued loss of the supporting structures of the teeth, again with a risk of abscess formation. The end point of both of these dental diseases is tooth loss. This will impact upon patients' ability to function, their quality of life, and may complicate ongoing medical management.[50, 112]

The situation on admission to hospital after stroke poses multiple demands on the care team. The changing oral care priorities as the patient moves from the acute to the recovery stage focus on providing stability of the oral environment and are best underpinned by maintaining the simple preventative measures that many of us undertake on a daily basis. This needs to be combined with early diagnosis and management of significant dental pathology, maintenance of the dentition whether it is natural or prosthetic and consideration of aspects of quality of life associated with having acceptable levels of oral function. Unfortunately, there is a lack of evidence about how this can best be achieved at each stage in a stroke patient's journey.

Future study design considerations

Emerging evidence supports the biological and clinical rationale for oral hygiene interventions in stroke care units.[54] To date, several oral hygiene intervention approaches appear to be feasible and well-tolerated in early-stage studies.[59, 98, 122, 123, 135, 136]

Commented [SH23]: Would it make sense to touch on brushing vs., mouth washes vs. others? The current section is a little non-specific.

CJS: this section seems a bit out on a limb, and not sure whether it fits here?

Other patient care groups have developed best practice guidelines for the provision of oral care, for example in palliative care,[137] paediatrics[138] and learning difficulties.[139] There is now a need to develop high quality evidence and consensus practice in order to improve staff awareness and training, and delivery of consistent and individualised oral care for stroke patients. This needs to begin in the acute phase post stroke and continue through the rehabilitation pathway and into nursing homes and patients' own homes. The Royal College of Physicians stroke guidelines[126] recommend assessment within four hours of admission for many aspects of patient care (swallow safety, continence, mobility, skin integrity/ulcer risk, communication, nutritional status, glasses & hearing aid requirements) but nothing specific as yet for individualised oral health/care needs.

Further research is needed to inform the optimal assessment tool for nursing staff in stroke units. This assessment needs to be economical, rapid and simple to use. In the absence of disease, it should indicate preventive care and in the presence of specific signs and symptoms should signpost staff to appropriate interventions. For example a dry mucosa indicates the need for regular regimes to rehydrate these tissues[88] and possibly a review of xerostomia inducing medications. Nursing staff need regular support from dental specialists and to be trained by appropriately qualified professionals in the provision of oral health assessments and care for stroke patients.[101]

Guidelines and individualised care programmes for each patient need to be informed by well-designed clinical trials. Evidence based guidance needs to be developed that will detail standards for mouth care delivery and the safest, most efficient equipment to use based on patients' individual oral health assessment. Multi-disciplinary involvement will be required in order to consider issues of positioning (physiotherapy), xerostomia (dentistry/pharmacy) dysphagia (speech & language therapy), nutritional status (dietetics) and patients' overall health (physicians).

Ultimately, large phase III randomised trials supported by health-economic analyses and implementation strategies will be required to inform evidence-based care and potentially change practice. However, prior to this, there are a number of fundamental questions that need adequately researched answers, including consideration of what oral hygiene interventions are trying to achieve during the various stages in the stroke pathway. For example, oral hygiene protocols, the required staff training and multi-disciplinary team involvement might conceivably differ in acutely unwell stroke patients at high-risk of aspiration, compared with ambulant patients participating in rehabilitation. Safety, acceptability and tolerability, cultural context as well as cost and complexity of oral care protocols are all important considerations. The spectrum and variation in existing 'usual' care and service provision (including role of specialist dental services) will also inform design of interventions for testing. Optimising accessibility and effectiveness of associated staff training requires further evaluation. Likewise, education and information provision for patients, their relatives and carers, and the associated behaviour-change aspects is an under-researched area.

Clinical trial design, including eligibility criteria, sample size, randomisation strategies and choice of outcome measures will be of key importance. Earlier stage interventions will most likely focus on feasibility, acceptability, tolerability; requiring mixed methods approaches. Surrogate outcomes for phase II studies, for example oral health or periodontal scoring tools, quantitative or qualitative analyses of oral microbiological flora will require further validation in this setting. The neglected area of oral health assessments will need to be addressed so that they are performed routinely including for patients who are intubated. Appropriate education, training and equipment will need to be considered, so that individuals with no previous training will feel sufficiently confident to carry out the assessments needed for the design of an oral care assessment protocol.[140]

Additional associated outcomes of importance to stroke patients might include oral-health quality of life scores and measures of nutritional status. Definitions of pneumonia should use algorithm-based approaches, preferably with independent adjudication.[141, 142] Phase III trials will require realistic recruitment strategies and real-world clinical outcomes and health-economic evaluation, likely to include generic stroke trial outcomes such as a shift on the modified Rankin Scale (mRS), survival, length of stay and antibiotic exposure. Implementation studies will need to address multi-level organisational aspects, including barriers and facilitators to change and adoption of evidence into policy and practice.

Future studies could benefit from exploration of the use of some of the novel technologies now available such as quantitative light induced fluorescence. This is a non-invasive imaging system capable of detecting dental plaque without the need for disclosing agents and demineralisation of dental enamel, simply by taking a photograph of the patient's mouth.[143] More comprehensive specialist oral assessments may be necessary and include for example gingival bleeding index, gingival inflammation, probing pocket depth and possibly assessment of particular bacterial species known to be pathogens.[54]

Commented [SH24]: Extremely challenging to attain these harder outcome measures, even in Phase III. There might be an argument that even if there was an improvement in the oral hygiene scores in the intervention group that this would be a reasonable surrogate for NHS implementation – especially if QoL is impacted.

CJS; Agree, although problem is that the mechanisms by which OH interventions might improve outcomes are not well defined at present. If pneumonia is an outcome measure, then mRS and mortality would follow as associated outcomes; wouldn't have mRS as a primary outcome though

Conclusions

Despite ongoing research in stroke care, and an increasing recognition of the importance of oral hygiene, there is a lack of knowledge about what oral care is currently provided as well as inadequate research to inform best practice in acute stroke care, rehabilitation and nursing home settings.

There is evidence that oral care is given low priority in acute and other stroke care settings, and staff feel inadequately prepared to provide oral care, especially when dysphagia or other problems are present. There is a dearth of research evidence to inform best practice in oral care in various stroke care settings. This review, however, will hopefully provide an objective platform for encouraging the health service to better incorporate oral health care into future stroke pathways, while stimulating greater engagement into this under-researched field of medicine.

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